U.S. Army Corps of Engineers
Fort Worth District

Final Quality Assurance Project Plan

Bosque and Leon River Watersheds Study

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US Army Corps of Engineers
Fort Worth District

MWH
MONTGOMERY WATSON HARZA

SIGNATURE PAGE

FINAL QUALITY ASSURANCE PROJECT PLAN

BOSQUE AND LEON RIVER WATERSHEDS STUDY

______________________________	______________________________
USACE, Fort Worth District Project Manager	Brazos River Authority Project Manager
______________________________	______________________________
MWH Project Manager	Laboratory Quality Assurance Officer
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USACE Laboratory Project Manager	

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ACRONYMS AND ABBREVIATIONS

AALA	Association of Laboratory Accreditation
BRA	Brazos River Authority
C-O-C	chain-of-custody
CRADA	Cooperative Research and Development Agreement
DQCR	Daily Quality Control Report
DQIs	data quality indicators
DQOs	data quality objectives
FSP	field sampling plan
LCS	laboratory control sample
LIMS	laboratory information management system
LQMP	laboratory quality management plan
MDL	method detection limit
MS/MSD	matrix spike/matrix spike duplicate
MWH	MWH Americas, Inc.
NIST	National Institute of Standards and Technology
PQLs	practical quantitation limits
QAPP	quality assurance project plan
QA	quality assurance
QAO	Quality Assurance Officer
QC	quality control
RPD	relative percent difference
SAP	sampling and analysis plan
SOP	standard operating procedure
SRM	standard reference material
SSHP	site safety and health plan
TEIHH	The Institute of Environment and Human Health
TTU	Texas Tech University

ACRONYMS AND ABBREVIATIONS (continued)

USACE	United States Army Corps of Engineers Fort Worth District
U.S. EPA	United States Environmental Protection Agency

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) was prepared as part of the Sampling and Analysis Plan (SAP) for the Bosque and Leon River Watersheds Study. This QAPP, in conjunction with the task-specific field sampling plans (FSPs) comprise the *Sampling and Analysis Plan - Bosque and Leon River Watersheds Study* (SAP; MWH Americas, Inc. [MWH] 2002a). In addition a site safety and health plan (SSHP) has been prepared to guide health and safety activities during the study.

As discussed in Section 1.0 of the SAP, in the future, additional stand-alone FSPs will be prepared as addenda for the field programs that will be conducted to support this study. Currently the FSP for the Longitudinal Stream Sampling Study has been completed and included with this submission. Because the data quality objectives (DQOs) and sample collection procedures are specific to the individual field programs, the DQOs and field sampling procedures for each task will be detailed in the task-specific FSPs, rather than this QAPP. This QAPP was prepared to meet the specific DQOs for each of these programs and will be incorporated by reference into the task-specific FSPs.

This QAPP was prepared for the U.S. Army Corps of Engineers Fort Worth District (USACE) by its environmental contractor, MWH, through authorization provided in contract DACW57-97-D-004, Task Order DY01, Modification No. 003 and was prepared in accordance with the USACE Statement of Work dated May 7, 2002, and the *Requirements for the Preparation of Sampling and Analysis Plans* (EM 200-1-3; USACE, 2001).

1.1 QAPP OBJECTIVES

The specific objective of this QAPP is to provide the guidance that will be followed for chemical analysis of perchlorate in surface water, groundwater, or sediment samples to ensure that these data are of sufficient quality to support the data end uses. This QAPP also presents the MWH and laboratory project organization, objectives, and functional activities, and the quality assurance (QA) and quality control (QC) procedures to be followed for all tasks conducted for this study.

In addition to the surface water, groundwater, and sediment samples included in this QAPP, plankton samples will be collected for perchlorate analysis during this study. The plankton samples will be analyzed by The Institute of Environment and Human Health (TEIHH) of Texas Tech University (TTU), Lubbock, Texas. The methodology to be used for plankton analysis is specific to TIEHH and their standard operating procedures (SOPs) for perchlorate analysis (Method 314.0 and a modified method for tissue analysis) are included in Appendix A of this document. The sample reporting limits, method specific calibration requirements, quality control criteria, and data reporting criteria are defined in the TTU SOPs. Plankton sample collection procedures will be defined in the project-specific FSP. Except for Appendix A, this QAPP is specific to water and sediment sample analysis.

Along with the EM 200-1-3 (USACE, 2001), the procedures detailed in this QAPP are in accordance with applicable professional technical standards and the United States Environmental Protection Agency (U.S. EPA) Region VI requirements and was prepared in accordance with the following guidance:

- *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations*, *EPA QA/R-5* (U.S. EPA, 1994a).

- *EPA 100-400 - Series Methods for the Determination of Inorganic Substances in Environmental Samples.* (U.S. EPA/600R-93-100, August, 1999).

- *USEPA Contract Laboratory Program National Functional Guidelines for Organic and Inorganic Data Review* (U.S. EPA, 1999).

- *Department of Defense Quality Systems Manual for Environmental Laboratories* (Version 1.0, October 2000)

- *Guidance for the Data Quality Objectives Process, EPA QA/G*-4 (U.S. EPA, 1994)

- *Data Quality Objectives for Hazardous Waste Site Investigations, EPA QA/G-4HW* (U. S. EPA, 2000) (as applicable).

This QAPP is required reading for all staff participating in the work effort. The QAPP will be in the possession of the field team during sample collection and in possession of the laboratory providing analytical services. All MWH and analytical laboratory personnel working on this project will be required to comply with the procedures documented in this QAPP to maintain comparability and representativeness of the resulting data.

1.2 DOCUMENT ORGANIZATION

The remainder of this QAPP is organized as follows:

- Section 2.0 Project Organization. This section describes the MWH and laboratory organization for this study.

- Section 3.0 Quality Assurance Objectives for Measurement Data. This section presents the field and laboratory analytical procedures that will be followed to meet the Bosque and Leon River Watersheds Study DQOs.

- Section 4.0 Sampling Procedures. This section references the task-specific FSPs. As discussed previously, because the procedures for each field task will vary, detailed sampling procedures will be defined in the task-specific FSPs.

- Section 5.0 Sample Custody. This section presents the laboratory chain-of-custody (C-O-C) procedures. Field C-O-C procedures will be defined in the task-specific FSPs.

- Section 6.0 Calibration Procedures and Frequency. This section includes the procedures that will be followed for instrument calibration for perchlorate analysis.

- Section 7.0 Analytical Procedures. The analytical procedures that will be followed for perchlorate analysis are described in this section.

- Section 8.0 Internal Quality Control Checks. The internal QC checks that will be followed by MWH and the laboratory are presented in this section.

- Section 9.0 Data Reduction, Reporting, Verification, and Validation. The procedures that will be followed for reducing, reporting, verifying, and validating field and chemical data are defined in this section.

- Section 10.0 Performance and Systems Audits. The procedures that will be followed by MWH and the laboratory for performance and systems audits are presented in this section.

- Section 11.0 Preventative Maintenance Procedures. The preventative maintenance procedures that will be followed by the laboratory are detailed in this section. General procedures for field-related tasks are presented in this section; specific details will be included in the task-specific FSPs.

- Section 12.0 Corrective Actions. This section defines the corrective actions that will be followed in the event of field or laboratory non-conformances.

- Section 13.0 Quality Assurance Reports to Management. The quality assurance reporting requirements for this study are presented in this section.

2.0 MWH AND LABORATORY ORGANIZATION

At the direction of the U.S. Army Corps of Engineers Fort Worth District and the Brazos River Authority (BRA), MWH has overall responsibility for the implementation of the field investigation. MWH's responsibilities include preparing this QAPP and all other related plans associated with this study. The field activities as described in the task-specific-FSPs will be conducted as a cooperative effort between MWH and BRA. The organization for this study is depicted in Figure 2-1. The following paragraphs focus on the MWH and the laboratory organizations and training requirements. Refer to Section 4.0 of the SAP for the overall study organization.

2.1 MWH Organization and Responsiblities

Project Manager. Mr. David Ebersold will be the Project Manager for the study. As the Project Manager, Mr. Ebersold will be fully responsible for contractual activities, and will serve as the focal point and main channel of communication between the USACE Project Manger and the MWH team regarding technical, financial, and scheduling matters. He will establish and interpret contractual policies, monitor schedule and cost, coordinate reporting, ensure necessary resources are made available, prepare long-range program plans, identify and resolve potential problems or conflicts, and provide for safe performance and quality of the work.

Field Sampling Manager. The Field Sampling Manager will be Mr. Ronald Hartline. Mr. Hartline will support the MWH Project Manager with program management duties and will also be responsible for leading and coordinating the field activities. His responsibilities include:

- Implementation of QC for technical data provided by the field staff including field measurement data.
- Adherence to work schedules provided by the Project Manager.
- Generation, review, and approval of text and graphics required for field team efforts.
- Coordination and oversight of subcontractors.
- Identification of problems at the field-team level and discussion of resolutions with the Project Manager.
- Day-to-day coordination with the Project Manager on technical issues.
- Development and implementation of task-specific FSPs.

- Coordination and management of field staff.
- Participation in the preparation of study reports.

Project Chemist. Craig Moore will be the Project Chemist for this study. Mr. Moore will report to the Project Manager, will interface with the Field Team Manager, and will provide direction and support for all study sampling activities, including sample collection, handling, storage, preservation, and shipment. Other responsibilities include:

- Interfacing with the laboratory on matters concerning chemical sampling and analysis, laboratory readiness, sampling schedules, sample containers, laboratory reports, verification and validation of data, and the resolution of nonconforming activities or data.
- Reviewing analytical data to ensure conformance with quality assurance testing and standards.
- Identifying, reporting, and recommending solutions for nonconforming sampling or analytical activities or data.
- Serving as a point of contact for issues related to environmental chemistry.

2.2 LABORATORY ORGANIZATION AND RESPONSIBILITIES

The United States Army Corps of Engineers (USACE) Engineer Research and Development Center Environmental Laboratory at the Environmental Chemistry Branch in Omaha, Nebraska will provide analytical services for this study.

Laboratory Project Manager. The USACE laboratory will assign a specific individual to assume Project Management responsibilities for this study. This individual will be the primary contact for MWH and will be responsible for ensuring that the study requirements as they relate to the laboratory are met. This individual will be responsible for scheduling sample analysis and ensuring that the data are generated in accordance with the specifications presented in this QAPP and will be responsible for monitoring the progress and timeliness of the work, reviewing work orders and laboratory reports, and processing any changes in the scope of work. This individual also will be responsible for ensuring that task-specific corrective action is taken when necessary to address problems identified by the QC sample results or QA audit results and for approving final analytical reports prior to submission to MWH.

Laboratory Quality Assurance Officer. The USACE laboratory quality assurance officer (QAO) will be responsible for ensuring that the laboratory QA/QC activities are performed in accordance with the requirements specified in both this QAPP and the laboratory's internal QAPP. Responsibilities will include (but not be limited to) preparing QA documents that define QA/QC procedures, reviewing and approving laboratory QC procedures, and oversight of inter-laboratory testing programs and laboratory certifications. This individual will also be responsible for monitoring method operation through periodic data reviews and technical system audits. Unacceptable findings will be reported to the appropriate individuals for corrective action. This individual will be responsible for signing the title page of this QAPP.

Laboratory Sample Custodian. The sample custodian reports directly to the USACE Laboratory Manager and will be responsible for:

- Receiving and inspecting samples.
- Recording information regarding sample condition on and signing the appropriate forms.
- Verifying the chain-of-custody and documenting any discrepancies.
- Notifying the USACE Laboratory Project Manager or other appropriate laboratory personnel of sample receipt and inspection.
- Assigning a unique identification number and customer number to each sample and logging it into the sample receiving log book and laboratory management information system (LIMS).
- Transferring samples to the appropriate laboratory sections
- Controlling and monitoring access and storage of samples and extracts.

Laboratory Technical Staff. All USACE laboratory staff involved with sample preparation and analysis will consist of experienced professionals who possess the degree of specialization and technical competence to perform the required work effectively and efficiently.

2.3 TRAINING REQUIREMENTS

All USACE laboratory staff associated with this study will have sufficient training to safely, effectively, and efficiently perform their assigned tasks. Training records will be available in the laboratory's quality management plan (LQMP).

PROJECT NO. *1970965.010103.ai 07/23/02 SLC*

USACE

Project Manager
Brian Condike
817-886-1482

Technical Manager
Wayne Elliott
817-886-1666

TIEHH

Associate Professor
Dr. Todd Anderson
806-885-4567

Research Assistant Professor
Dr. Phil Smith
806-885-4567

Assistant Professor
Dr. Andrew Jackson
806-742-2801

MWH

Project Manager
David Ebersold
626-568-6943

Field Sampling Manager
Ronald Hartline
214-360-9929

Field Sampling Technician
Kartik Gandhi
214-360-9929

Project Chemist
Craig Moore
801-617-3200

BRA

Project Manager
Kyle Headley
254-776-1441

Environmental Services Manager
Gayle Haecker
254-776-1441

Environmental Field Operations Supervisor
Rob Fuentes
254-776-1441

USACE Laboratory

Chemist
Prem Arora
402-444-4318

U.S. Army Corps of Engineers	
PROJECT: BOSQUE AND LEON RIVER WATERSHEDS STUDY	
DRAWING TITLE: PROJECT ORGANIZATION CHART	
MWH MONTGOMERY WATSON HARZA	Sheet 1 of 1 sheets
SCALE No Scale	FIGURE 2-1

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

Data quality refers to the level of reliability associated with a particular data set or data point. The data quality associated with environmental measurement data is a function of the sampling plan rationale, the sample collection procedures, and the analytical methods and instrumentation used in making the measurements. The overall QA objective is to develop and implement procedures for field sampling, C-O-C, laboratory analysis, and data reporting that will provide data that meet task-specific DQOs and that are legally defensible. Data quality objectives are qualitative and quantitative statements that specify the field and laboratory data quality necessary to support specific decisions or regulatory actions. The DQOs describe which data are needed, why the data are needed, and how the data are to be used to meet the needs of the study. DQOs also establish numeric limits for the data to allow the data user (or reviewers) to determine whether the data collected are of sufficient quality for their intended use.

The DQOs for the Bosque and Leon River Watersheds Study will be included in Section 2.2 of the task-specific FSPs and were developed in accordance with the *Guidance for the Data Quality Objectives Process, EPA QA/G*-4 (U. S. EPA, 1994) and additional guidance as provided in *Data Quality Objectives for Hazardous Waste Site Investigations, EPA QA/G-4HW* (U. S. EPA, 2000). The remainder of this section defines how the data will be assessed to meet the task-specific DQOs and the criteria that will be used to define acceptable limits of uncertainty.

3.1 DATA TYPES

The data types required for this study are based on the task-specific DQOs, the end use of the analytical data, and the level of documentation. Both screening and definitive data will be collected during the study. The specific type of data that will be collected for each task are defined in Section 2.0 of the FSPs. Whether data are considered screening or definitive is based on the method of sample collection, preparation, and analysis. Definitive data include data that are collected using standard sampling methodology and analytical methodology of known precision and accuracy. Screening data include data that are collected using non-standard sampling methodology or collected using rapid, less precise methods of analysis with less rigorous sample preparation or quality control as compared to analytical methods from which definitive data are generated.

3.2 DATA QUALITY DEFINITION AND MEASUREMENT

To determine the overall quality of definitive data, the results of QC sample analysis will be evaluated in terms of the precision, accuracy, representativeness, completeness, and comparability, data quality indicators (DQIs) established for this study. The QC samples that will be used to assess the quality of both the field and laboratory data (prepared both in the laboratory and in the field) are described later in this section. A summary of the chemical data quality control evaluation program in terms of the DQIs is presented in Table 3-1. Method specific quality control procedures, frequency of QC sample analysis and acceptance criteria, and laboratory corrective action summaries that will be used as guidance for this study are included in Appendix B.

3.2.1 Precision

Definition. Precision is the reproducibility of measurements under a given set of conditions. For large data sets, precision is expressed as the variability of a group of measurements compared to their average value (i.e., standard deviation). For duplicate or replicate measurements, precision is expressed as the relative percent difference (RPD) of a data pair and is calculated using the following equation:

$$RPD = \frac{|A - B|}{\frac{(A + B)}{2}} \times 100$$

Where A and B are the reported concentrations for duplicate sample analyses.

Field Precision. For this study, field precision will be assessed through the collection and analysis of field duplicate samples.

Laboratory Precision. Analytical laboratory precision will be assessed using the calculated RPD between the following data:

- Matrix spike and matrix spike duplicate (MS/MSD) sample data.
- Investigative and associated matrix duplicate sample data.
- Investigative and associated field duplicate (surface water or groundwater) or replicate (sediment) sample data.
- Laboratory precision will also be assessed for three or more replicated samples (e.g., response factors for calibration standards).

3.2.2 Bias and Accuracy

Bias Definition. Bias refers to the systematic or persistent distortion of a measurement process that causes errors in one direction (above or below the true value or mean). Bias is a term that is related to but is not interchangeable with accuracy. The bias of a measurement system is affected by the sample matrix or by errors introduced during sample collection, preservation, handling, preparation, and analysis. Bias will be evaluated using the percent recovery calculated using the following equation:

$$\text{Percent Recovery} = \frac{|A - B|}{C} \times 100$$

Where: A is the target analyte concentration determined analytically from the spiked sample.

B is the background level determined by a separate analysis of the unspiked sample.

C is the concentration of spike added.

Field Bias. Although Bias of the field program cannot be assessed quantitatively, a qualitative bias assessment for this study will be conducted by reviewing the sample collection, preservation, handling, and shipping procedures for compliance with the specifications presented in the task-specific FSPs.

Laboratory Bias Objectives. Laboratory bias will be assessed quantitatively through the analysis of MS/MSD samples and standard reference materials (SRM), which includes laboratory control sample (LCS), and response factors for calibration standards.

Accuracy Definition. Accuracy is the degree of agreement of a measurement or an average of measurements with an accepted reference or "true" value. Accuracy includes a combination of random error and systematic error (bias) components that result from sampling and analytical operations.

3.2.3 Representativeness

Definition. Representativeness is a qualitative expression of the degree to which sample data accurately and precisely represent a characteristic of a population, a sampling point, or an environmental condition. Representativeness is maximized by ensuring that, for a given task, the number and location of sampling points and the sample collection and analysis techniques are appropriate for the specific investigation, and that the sampling and analysis program provides information that reflects "true" site conditions.

Field Data. Representativeness of field data is dependent upon the proper design of the data collection procedures. Representativeness of the field data will be evaluated by assessing whether the sampling procedures defined in the task-specific FSPs and this QAPP were followed during sample collection. In addition, the analytical results from field duplicate or replicate samples also will be used to evaluate the representativeness of the field sampling procedures.

Laboratory Data. Laboratory data will be evaluated for representativeness by assessing whether the laboratory followed the specified analytical criteria in this QAPP and their

SOPs, assessing compliance with holding time criteria, and the results of method and instrument blank samples and field replicate or duplicate samples.

3.2.4 Comparability

Definition. Comparability is a qualitative parameter that expresses the confidence with which one data set may be compared to another. Comparability is dependent on similar QA objectives and is achieved through the use of standardized methods for sample collection and analysis, the use of standardized units of measure, normalizing results to standard conditions, and the use of standard and comprehensive reporting formats as defined by this QAPP.

Field Data. Field data comparability is dependent on the use of similar and standard sampling and analytical methodology and the use of standard units of measure between different tasks at a site. For this study, field data will be collected using standard sampling and measurement procedures. All field data will be recorded in the field logbook or on the applicable field forms (i.e., sample log forms or C-O-C forms). Comparability of field data will be evaluated by reviewing the field documentation to determine whether the field data collection procedures and sample collection, handling, and shipping protocols specified in this QAPP and the task-specific FSPs were followed.

Laboratory Data. Laboratory data comparability is dependent on the use of similar sampling and analytical methodology and standard units of measure between different tasks at a specific site. For this study, chemical data will be collected using standard sampling and analyses procedures. Data comparability will also be assessed by comparing investigative sample data to QA or QC sample data.

3.2.5 Completeness

Definition. Completeness is a measure of the amount of valid data obtained from a measurement system relative to the amount of data scheduled for collection under correct, normal conditions. Completeness measures the effectiveness of the overall investigation in collecting the required samples, completing the required analyses, and producing valid results. Completeness will be calculated using the following equation:

$$\text{Completeness} = \frac{\text{Number of valid data points}}{\text{Total number of measurements}} \times 100$$

Where: the number of valid data points is the total number of valid analytical measurements based on the precision, accuracy, and holding time evaluation.

Field Data. Field completeness is a quantitative measure of the actual number of samples collected compared to those samples scheduled for collection. The field data completeness goal for data collected under this QAPP is 95 percent.

Laboratory Data. Laboratory data completeness is a quantitative measure of the percentage of valid data for all analytical data as determined by the precision, accuracy, and holding time criteria evaluation. Completeness will be calculated using the completeness equation by dividing the total number of valid data points by the total number of data points. The laboratory completeness goal for data collected under this QAPP is 95 percent.

3.3 QUALITY CONTROL SAMPLES

The quality control parameters and samples that will be used to evaluate analytical data in terms of the DQIs are described in this section. These include QC samples prepared both in the field and by the laboratory. A summary of QC sample evaluation in relation to the DQIs is presented in Table 3-1. Method specific quality control procedures, frequency of QC sample analysis, acceptance criteria (control limits), and corrective actions are included in Appendix B.

3.3.1 Field Program

For field sampling, quality control samples are used to assess sample collection techniques and to assess environmental conditions during sample collection and transport. For this study field QC samples will include temperature blanks, equipment blanks (as applicable), and field duplicates (samples that are submitted blind to the laboratory).

Temperature Blanks. Temperature blanks will be used to evaluate the internal temperature of the cooler and assess whether the sample temperature criterion of 4°C $\pm$ 2°C was met during sample shipment. The temperature of the blank is measured at the time the samples are received by the laboratory and recorded on the chain of custody. Temperatures that exceed the temperature criterion indicate that the samples may not have been handled or transported properly.

Field Duplicate Samples. Field duplicate samples are surface water, sediment, soil, or groundwater samples that are submitted blind to the laboratory and will be used to assess variability in the sample media and to assess sampling and analytical precision. A field duplicate sample for surface water or groundwater is a single grab sample that is split into two samples during collection. A field duplicate sample for sediment or soil media is taken from a single location and homogenized. Equal aliquots from the homogenized media are used to fill the sample containers. For each field duplicate sample pair, one of the samples is labeled with the correct sample identification and the other is labeled with fictitious sample identification. This duplicate sample pair is then submitted to the same laboratory as two separate samples. Precision will be evaluated by calculating the RPD between the field duplicate sample pairs for all analytes detected at or above the method detection limit (MDL). RPD calculations will not be performed when either one or both duplicate sample results for the field duplicate sample pairs are reported as less than the MDL.

Equipment Blanks. Equipment blanks are samples of analyte free (deionized) water that are rinsed over decontaminated sampling equipment, collected, and submitted for analysis. These samples are used to assess cross-contamination from the sampling equipment, in addition to incidental contamination, the sample container, and/or preservatives.

3.3.2 Laboratory Program

The laboratory will, as a minimum, analyze internal QC samples at the frequency specified by the analytical method and in this QAPP. Method-specific quality control procedures, frequency of QC sample analysis, acceptance criteria (control limits), and corrective actions are provided in Appendix B. The following paragraphs discuss holding time and the QC samples that the laboratory will use to assess data quality.

Sample Holding Time. Sample holding time reflects the length of time that a sample or sample extract remains representative of environmental conditions. For methods that do not require sample extraction one holding time will be evaluated, the length of time from sample collection to analysis. For methods that require sample extraction prior to analysis two holding times will be evaluated; the length of time from sample collection until sample extraction, and the length of time from sample extraction to sample analysis. These holding times will be compared to the holding times specified for these methods. Samples will not be analyzed outside of the specified method holding times without approval by the MWH Project Chemist or the USACE project manager. The method holding time criterion for perchlorate is 28 days from sample collection to analysis.

Method Blanks. Method blanks will be used to monitor the laboratory preparation and analytical systems for interferences and contamination from glassware, reagents, sample manipulations, and the general laboratory environment. The method blank is an analyte-free matrix (reagent grade water or laboratory grade sand) to which all reagents will be added in the same volumes or proportions as used in sample processing. Method blanks will be taken through the entire sample preparation/extraction and analytical process. Method blanks will be prepared and analyzed with each analytical or preparation batch of environmental samples up to a maximum of 20 samples of a similar matrix.

Laboratory Control Samples. Laboratory control samples (LCS) will be used to measure laboratory accuracy in the absence of matrix interference. Laboratory control samples are prepared in the laboratory and consist of samples of a known matrix (reagent grade water or laboratory grade sand) spiked with a known quantity of specific target analytes in accordance with the laboratory SOPs. These samples are taken through the entire sample preparation and analytical process. LCSs will be prepared and analyzed with each analytical or preparation batch of environmental samples up to a maximum of 20 samples of a similar matrix.

Matrix Spikes and Matrix Spike Duplicates. Matrix spikes measure matrix-specific method performance and will be used to assess accuracy and precision. Unlike LCSs, MS/MSD samples will be used to assess the influence of the sample media (media interference) on the analysis. Samples for MS/MSD analysis will be site specific and analyzed at a frequency of five percent of the total number of samples for each media type. Each MS/MSD sample will be spiked with the compounds specified by the analytical method prior to sample extraction or analysis in accordance with the Laboratory's SOPs.

Matrix Duplicates. Matrix duplicates will be used to assess laboratory precision for perchlorate. A matrix duplicate consists of a single grab sample that is split into two equal portions. This sample pair is then submitted to the same laboratory as two separate samples that are not "blind". Precision will be evaluated by calculating the RPD between the investigative sample and its matrix duplicate and comparing the results to the study acceptance criteria.

Field Duplicates. As discussed previously, field duplicates (surface water, sediment, soil, or groundwater samples) will be used to assess both sampling and analytical precision. The purpose of submitting samples "blind" to the laboratory is to assess the consistency or precision of the laboratory's analytical system. Precision will be evaluated by calculating the RPD between the field duplicate samples.

3.4 LABORATORY BATCH QUALITY CONTROL LOGIC

The frequency of instrument calibration and QC sample analysis for the analytical methods are batch controlled. All sample data for this study will be associated with sample batch QC samples that were extracted or prepared concurrently with the site samples and analyzed in the same analytical batch (analyzed on the same instrument relative to the primary sample results). The following paragraphs define sample and instrument batches.

For this study, a sample batch is a group of twenty or less environmental samples of the same matrix which are extracted or prepared within the same time period (concurrently) or in limited continuous sequential time periods. Keeping batches "open" for more than two hours will not be accepted; samples and their associated QC samples (method blank, LCS, matrix duplicate, and MS/MSD) will be prepared in a continuous process. The sample batch will be analyzed sequentially on a single instrument (as practicable).

The instrument batch is a group of 20 or less environmental samples that are analyzed together within the same analytical run sequence as defined by the method calibration criteria or in continuous sequential time periods. Samples in each batch will be of similar matrix (e.g., sediment or surface water and groundwater), will be treated in a similar manner, and will use the same reagents.

TABLE 3-1

CHEMICAL DATA QUALITY CONTROL EVALUATION IN TERMS OF DATA QUALITY INDICATORS

PARCC Parameter	Quality Control Program	Evaluation Crite
Precision	Field Replicate or Duplicate Sample Pairs	Relative Percent Difference
	Matrix Spike/Matrix Spike Duplicate Sample Pairs	Relative Percent Difference
	Investigative Sample/Matrix Duplicate Sample Pairs	Relative Percent Difference
Bias	Matrix Spike	Percent Recovery
	Matrix Spike Duplicate	Percent Recovery
	Laboratory Control Sample	Percent Recovery
	Standard Reference Materials	Percent Recovery
Representativeness	Holding Time	Qualitative, Degree of Confidence
	Method Blanks	Qualitative, Degree of Confidence
	Field Replicate or Duplicate Samples	Quantitative/Qualitative, Degree o
Comparability	Standard Field Procedures	Qualitative, Degree of Confidence
	Standard Analytical Methods	Qualitative, Degree of Confidence
	Standard Units of Measure	Qualitative, Degree of Confidence
Completeness	Valid Data	Percent Acceptable Data

Data Quality Indica Precision, Bias, Accuracy, Representativeness, Completeness, and Comparability

4.0 SAMPLING PROCEDURES

4.1 SAMPLE COLLECTION PROCEDURES

The sample collection procedures will be defined in Section 2.0 of the task-specific FSPs.

5.0 SAMPLE CUSTODY

To ensure that samples are identified correctly and remain representative of the environment, the sample documentation and custody procedures outlined in this section will be used during the sampling program to maintain and document sample integrity during collection, transportation, storage, and analysis. Field sampling personnel will be responsible for ensuring that proper documentation and custody procedures are initiated at the time of sample collection, and that individual samples can be tracked from the time of sample collection until custody of the samples is transferred to the laboratory. The laboratory will be responsible for maintaining sample custody and documentation from the time the laboratory receives the samples until final sample disposition.

To minimize common problems such as labeling errors, chain of custody errors, transcription errors, preservation failures, etc., detailed procedures for properly recording sample information and analytical requests on chain of custody records, for preserving samples as appropriate, and for sample packaging and shipment are described below. Field sampling personnel will be required to become familiar with the task-specific FSPs, and this QAPP, prior to initiating fieldwork.

5.1 CHAIN-OF-CUSTODY

Chain-of-custody procedures provide an accurate written record of the possession of each sample from the time it is collected in the field through laboratory analysis. A sample is considered in custody if one of the following applies:

- It is in an authorized person's immediate possession
- It is in view of an authorized person after being in physical possession
- It is in a secure area after having been in an authorized person's physical possession
- It is in a designated secure area, restricted to authorized personnel only.

5.1.1 Field C-O-C Procedures

Sample custody and documentation procedures will be initiated at the time each sample is collected. The field sampler has ultimate responsibility for the samples until they are submitted to a commercial carrier for transport to the laboratory. The field sampler's responsibility ends after transfer of the samples to the carrier, who assumes sample responsibility. Refer to Section 2.0 of the task-specific FSPs for detailed procedures regarding field documentation.

5.1.2 Laboratory C-O-C Procedures

Upon receipt by the laboratory, the integrity of the shipping container will be checked by verifying that the custody seal is not broken. The cooler will be opened and examined for evidence of proper cooling, and the presence of temperature blanks. The individual sample containers will be checked for breakage, damage, or leakage. The contents of the shipping container will then be verified against the C-O-C. If any problems are found, they will be documented on the sample custody form(s) and the Project Chemist will be notified immediately. The shipping receipts will be placed with the C-O-C records and stored in the study file.

If the samples and documentation are acceptable, each sample container will be assigned a unique laboratory identification number and entered into the laboratory's sample tracking system. Sample tracking will be documented in the laboratory information management system (LIMS), or other appropriate tracking system. Other information that will be recorded includes date and time of sampling, sample description, due dates, and required analytical tests.

When sample log-in has been completed, the samples will be transferred to limited-access temperature controlled storage areas. The sample storage areas (coolers, refrigerators) will be kept at $4^{o}C \pm 2^{o}C$ and their temperatures will be recorded daily with thermometers calibrated against National Institute of Standards and Technology (NIST) thermometers.

The laboratory will follow their SOPs for sample log-in, storage, tracking, and control. These procedures will be documented and available for review in the laboratory's LQMP.

Sample custody will be maintained within the laboratory's secure facility until the samples are disposed. The laboratory will be responsible for sample disposal, which will be conducted in accordance with all applicable local, state, and federal regulations. All sample disposals will be documented and the records will be maintained by the laboratory in the project file.

5.2 FINAL PROJECT FILES CUSTODY PROCEDURES

The final project files will be maintained by MWH and will be under the custody of the MWH Field Sampling Manager in a secured area. The final project files will be made available for USACE Fort Worth District review upon request. At a minimum, the project file will contain all relevant records including:

- Field logbooks
- Field data and data deliverables
- Photographs
- Design drawings
- All original field logs
- All construction details
- Laboratory data deliverables
- Data verification reports
- Data assessment reports.

- Progress reports, QA reports, interim study reports, etc
- All custody documentation (tags, forms, airbills, etc.).

6.0 CALIBRATION PROCEDURES AND FREQUENCY

6.1 FIELD INSTRUMENT CALIBRATION PROCEDURES

Field equipment or instruments will be calibrated in accordance with the manufacturer's directions and expected field conditions, and calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of resulting data can be assessed. The specific procedures for field equipment or instrument calibration is defined in Section 2.0 of the task-specific FSPs.

6.2 LABORATORY INSTRUMENT CALIBRATION PROCEDURES

Instrument calibration is necessary to ensure that the analytical system is operating correctly and functioning at the proper sensitivity to meet the study-specific practical reporting limits, i.e. practical quantitation limits (PQLs). Calibration establishes the dynamic range of an instrument, establishes response factors to be used for quantitation, and demonstrates instrument sensitivity. Criteria for calibration are specific to the instrument and the analytical method. The following paragraphs describe laboratory instrument calibration procedures.

6.2.1 Calibration Standard Preparation

Standard/Reagent Preparation. All instruments will be calibrated in accordance with the laboratory's SOPs. To ensure the highest quality standard, primary reference standards will be used by the laboratory and will be obtained from the NIST, EPA Cooperative Research and Development Agreement (CRADA) vendors, American Association of Laboratory Accreditation (AALA) vendors, or other reliable commercial sources. When standards are received at the laboratory, the date received, supplier, lot number, purity, concentration, and expiration date will be recorded in a standards logbook. Vendor certifications for the standards will be retained in the files and made available upon request.

Standards will be obtained in their pure form or in a stock or working standard solution. Dilutions will be made from the vendor standards. All records regarding standards will unambiguously trace their preparation, use in calibration, expiration dates, and quantitation of sample results. All standards will be given a standard identification number, and the following information recorded in the appropriate file (standards logbook): source of standard, the initial concentration of the standard, the final concentration of the standard, the volume of the standard that was diluted, the solvent and the source and lot number of the solvent used for standard preparation, the expiration date of the standard, and the preparer's initials. All standards will be verified prior to use.

After preparation and before routine use, the identity and concentration of the standards will be verified. Verification procedures include a check for chromatographic purity (if applicable) and verification of the standard's concentration by comparing its response to a standard of the same analyte prepared or obtained from a different source. Reagent purity will be assessed by analyzing an aliquot of the reagent lot using the analytical method in which it will be used; for example, every lot of laboratory grade water is analyzed for undesirable contaminants prior to use in the laboratory. Standards will be routinely checked for signs of deterioration (e.g., discoloration, formation of precipitates, and changes in concentration), and will be discarded if deterioration is suspected or the expiration date has passed. Expiration dates will be taken from the vendor recommendation, the analytical methods, or from internal research.

6.2.2 Instrument Calibration

Criteria for calibration are specific to the instrument and the analytical method. Each instrument will be calibrated according to the analytical methods following manufacturer's guidelines and using standard solutions appropriate to the type of instrument and the linear range established for the method. All reported analytes will be present in both initial and continuing calibrations, which must meet the acceptance criteria specified in the method and summarized in Appendix B. The instrument calibration will be from lowest to the highest calibration standard and the lowest calibration standard concentration will be at the PQL for each target analyte. Either calibration curves or response factors will be used to determine analyte concentrations. The following paragraphs describe the general requirements for instrument calibration, and standards preparation and traceability.

All instrument calibration information will be documented, and at a minimum include the equipment to be calibrated, the reference standards used for calibration, the calibration techniques, actions, acceptable performance tolerances, frequency of calibration, and calibration documentation format. The laboratory will maintain records of standard preparation and instrument calibration. Calibration records will include daily checks using standards prepared independently of the calibration standards, and instrument response will be evaluated against established criteria. The analysis logbook, maintained for each analytical instrument, will include at a minimum the date and time of calibration, the initials of the person performing instrument calibration, and the calibrator reference number and concentration. Calibration procedures for the methods included in this QAPP are presented in Appendix B and are from EPA method 314.0, *Determination of Perchlorate in Drinking Water Using Ion Chromatography* (EPA/600R-93/100, November 1999). A summary of calibration procedures, corrective actions, and QC acceptance limits are provided in Appendix B.

7.0 ANALYTICAL PROCEDURES

This section describes the analytical procedures that will be used for the acquisition of chemical data and includes the relevant aspects of field and laboratory procedures (sample preparation and extraction procedures, instrumentation, MDLs, instrument detection limits, and practical quantitation limits (PQLs). Analytical quality control requirements, evaluation criteria, acceptance criteria, calibration procedures, preventative maintenance, and corrective actions are discussed in following sections.

7.1 FIELD ANALYTICAL PROCEDURES

The field analytical procedures are task-specific and defined in the task-specific FSPs.

7.2 LABORATORY ANALYTICAL PROCEDURES

7.2.1 Analytical Methodology

Method 314.0 (*EPA 100-400 — Methods for the Determination of Inorganic Substances in Environmental Samples* [EPA/600R-93/100, August 1999]) for perchlorate analysis in will be used for all sediment, surface water or groundwater sample analysis for this study. This method is briefly described in Table 7-1. All samples will be prepared and analyzed in accordance with the referenced analytical method and in accordance with the laboratory's SOPs.

7.2.2 Method Detection Limits and Practical Quantitation Limits

Method Detection Limits. The MDL is an empirically derived value that is used to estimate the lowest concentration a method can detect in a matrix-free environment. The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. MDLs will be updated as scheduled in the laboratory's SOPs following guidance in 40 CFR 136 Appendix B.

Practical Quantitation Limits. The PQL is the lowest concentration that can be reliably achieved within limits of precision and accuracy during routine operating conditions and is based on the MDL for each analyte. The PQLs for the analytical methods included in this QAPP are presented in Appendix B.

7.2.3 Reporting Requirements

The following criteria for reporting data apply for all samples:

- All perchlorate non-detections will be reported (at a minimum) as less than the MDL.

- If target analytes are detected between the MDL and PQL, they will be reported as quantified and flagged with a "J" qualifier to indicate the data are estimated.

- If target analytes are detected at or above the PQL, they will be reported as quantified.

Additional Reporting Requirements for Definitive Data. The Project Chemist will be notified immediately regarding the failure of perchlorate results to meet the MDL or PQL to assess potential corrective action. The decision to implement corrective action will be based on whether there are any analytical alternatives or clean up steps that would improve the reporting limit and whether the elevated reporting limits will adversely affect data use. Any data that do not meet the MDLs or PQLs due to sample dilution will be included in the case narrative and the supporting documentation (chromatograms) will be included in the data packages.

TABLE 7-1

SUMMARY OF LABORATORY ANALYTICAL PROCEDURES
(Page 1 of 1)

Method[a]	Analytical Procedure
EPA 314.0 Perchlorate by Ion Chromatography	A volume of sample is introduced into an ion chromatograph. Perchlorate is separated by ion chromatography column and measured with a conductivity detector. The sample concentration is quantified by comparing the instrument response to the 5-point calibration curve.

(a) EPA 100-400 Series Methods for the Determination of Inorganic Substances in Environmental Samples, (EPA/600R-93/100. August 1999).

8.0 INTERNAL QUALITY CONTROL CHECKS

Internal quality control checks are used to evaluate whether field measurements and sampling procedures and laboratory analytical method performance is within acceptable limits of precision and accuracy. The following sections describe the internal QC that will be followed for both field and laboratory activities.

8.1 SAMPLE COLLECTION

The bias and precision of the field sampling procedures will be assessed as described in Section 3.0 of this QAPP. Sample representativeness will be assessed by the analysis of field duplicate or field replicate samples. These samples are described in Section 3.0.

8.2 LABORATORY ANALYSIS

The general objectives of the internal laboratory QC program are to:

- Ensure that all procedures are documented, including any changes in administrative and/or technical procedures.

- Ensure that all analytical procedures are validated and conducted according to method guidelines and laboratory SOPs.

- Monitor the performance of the laboratory using a systematic inspection program.

- Ensure that all data are properly reported and archived.

The laboratory will conduct internal quality control checks for analytical methods in accordance with their SOPs, the individual method requirements, and this QAPP. The laboratory will notify the Project Manager or Project Chemist in writing before making significant changes resulting from corrective actions to the task-specific FSPs, this QAPP, or analytical methodology. The USACE Project Manager will be notified if the data impacts the task specific DQOs.

Laboratory quality control consists of two distinct components, a laboratory component and a matrix component. The laboratory component measures the performance of the laboratory analytical process during sample analyses, while the matrix component measures the effects of a specific media on the method performance. The QC samples that will be used to assess the laboratory component and the media component of analysis are described Section 3.0 of this QAPP. The criteria against which the QC data will be evaluated are listed in Appendix B. Corrective actions for instrument calibrations or QC sample data out of compliance are listed in the corrective action summary table included in Appendix B.

9.0 DATA REDUCTION, REPORTING, VERIFICATION AND VALIDATION

9.1 DATA REDUCTION

9.1.1 Field Data Reduction

Field data will be used as reported from the direct read instruments.

9.1.2 Laboratory Data Reduction

The laboratory will reduce all analytical data (both screening and definitive) in accordance with the analytical methods and the guidance presented in Sections 3.0 and 6.0 of this QAPP. Refer to Section 3.0 of this QAPP for equations that will be used by the laboratory to assess precision and bias, and refer to Section 6.0 and Appendix B regarding instrument calibration and target analyte quantitation.

9.2 DATA REVIEW

9.2.1 Field Data Review

Prior to use, the MWH Field Sampling Manager will review all field data. The data will be reviewed to assess whether the procedures specified in the task-specific FSPs and this QAPP were followed and to identify inconsistencies and/or anomalous values. Any inconsistencies will be resolved immediately, if possible, by seeking clarification from those personnel responsible for data collection. At a minimum, the information contained in boring logs, field notes, field-sampling forms, and C-O-C records, as applicable, will be included in the review process. All changes or corrections to this field documentation will also be reviewed. A narrative will be prepared that describes any deviations from the procedures, explains any qualifications regarding the data quality, and describes any significant problem identified during the review process.

9.2.2 Laboratory Data Review

The laboratory will perform in-house data review under the direction of the laboratory Project Manager and/or the laboratory QAO and will prepare and retain full analytical and QC documentation. All data will be reviewed prior to release by the laboratory. In general, the laboratory data review will be conducted as described in the following paragraphs:

The bench analyst will conduct the initial data review based on established protocols specified in laboratory SOPs, analytical method protocol, and task-specific data quality objectives. At a minimum this review will include the following:

- An assessment of sample preparation procedures and documentation for accuracy and completeness.

- An assessment of sample analysis procedures and documentation for accuracy and completeness.

- Assessments of whether the appropriate SOPs were followed.

- An assessment analytical results for accuracy and completeness.

- An assessment of whether QC samples are within established control limits and method blank data are acceptable.

- An assessment of whether documentation is complete (e.g., all anomalies in the preparation and analysis have been documented, out-of-control forms, if required, are complete, holding times are documented, etc.).

The calculations that will be used to evaluate precision and bias are defined in Section 3.0 of this QAPP. The acceptance criteria for calibration, precision, and bias assessment, and the corrective action summaries are provided in Appendix B.

When an analysis of a QC sample (blank, spike, or similar sample) indicates that the analysis of that batch of samples is not in control, the analyst will immediately bring the matter to the attention of the appropriate designated laboratory QC staff (QAO, Project Manager, Section Leader, etc.). This individual will determine whether the analysis can proceed, or if selected samples should be rerun, or specific corrective action needs to be taken before analyzing additional samples. Out-of-control analyses and information justifying accuracy or precision outside acceptance criteria will be documented. A Nonconformance Report will be prepared for all laboratory analysis out of control events that require documentation. The MWH Project Chemist will be notified as soon as feasibly possible to determine appropriate corrective action for out-of-control events resulting in unacceptable data.

After this review is complete, the analyst will sign the applicable control documentation associated with the analytical batch and forward to the appropriate reviewer. This reviewer (department manager, QAO, etc.) will be responsible for review and approval of the analytical control documentation associated with each analytical batch, as well as any corrective action explanations provided by the analyst. This individual will also be responsible for determining whether the analytical data meet quality control criteria established by the analytical methods and by this QAPP and for identifying QC problems that require further resolution. A permanent record of any corrective actions will be maintained in the laboratory files.

The laboratory Project Manager will provide the final review and approval of the analytical data that have been approved by the analyst and other designated reviewer.

The laboratory Project Manager will also be responsible for reviewing all final data reports for proper format and reporting consistency prior to releasing the reports to MWH. This review will include the following as a minimum:

- Laboratory name and address.
- Sample information (includes unique sample identification, sample collection date and time, date of sample receipt, and date(s) of sample preparation and analysis).
- Analytical results reported with an appropriate number of significant figures.
- Reporting limits reflecting dilutions, interferences, and corrections for dry weight as applicable.
- Method references.
- Appropriate QC results and correlations for sample batch traceability and documentation.
- Data qualifiers with appropriate references and narrative on the quality of results.
- Confirmation that task-specific requirements have been met.

The laboratory Project Manager and/or the laboratory QAO will also be responsible for qualifying any data that may be unreliable. Data qualifications will be based on the laboratory SOPs and the analytical method, and the principles outlined in the Department of Defense *Quality Systems Manual for Environmental Laboratories* (Version 1.0, October 2000), USACE EM 200-1-3, Appendix I *Shell for Analytical Chemistry Requirements* (February 2001) and the *USEPA Contract Laboratory Program National Functional Guidelines for Organic and Inorganic Data Review* (U.S. EPA, 1994/1999). The flags that will be used by the laboratory for data qualification are listed in Table 9-1.

9.3 Data Reporting

9.3.1 Field Data

Field data will be reported as described in Table 9-2 and presented in a format that will facilitate data review and evaluation. Tables, graphs, or figures will be used to present the data in associated study reports.

9.3.2 Laboratory Data

The analytical data will be reported in a format organized to facilitate data verification. The information that will be included in the laboratory data packages is listed in Table 9-2.

9.4 DATA VERIFICATION

As described in Section 3.0, the validity of the field and analytical data will be evaluated using the data quality indicators, which are quantitative and qualitative statements that describe data quality. The DQIs will be used to determine whether the DQOs of this investigation have been met by comparing QC sample results and standard procedures with acceptance criteria established for this investigation. For this study, all definitive data will be validated by MWH based on the principles outlined in the Department of Defense *Quality Systems Manual for Environmental Laboratories* (Version 1.0, October 2000) and the USACE EM 200-1-3, Appendix I *Shell for Analytical Chemistry Requirements* (February 2001). Level III data verification will be performed for all sample data. Level IV data verification will be performed for 10 percent of the sample data. If significant problems are identified during the Level IV data verification, additional data will be validated using Level IV procedures until data problems are resolved.

9.4.1 Field Data Verification

The MWH Field Sampling Manager or designee will assess the quality of field data. Because there are no formal quantitative procedures for verification of screening data, which includes field data, field data will be quantitatively evaluated in terms of the DQIs as described in Section 3.0.

9.4.2 Laboratory Data Verification

The MWH Project Chemist will perform data verification. As discussed previously, there are no formal data verification requirements for screening data. The following discussions regarding data verification are specific to definitive data; screening data will not be included in this process.

The objective of the definitive data verification is to provide a data review that verifies the laboratory QC results. This verification will be based on the principles outlined in the Department of Defense *Quality Systems Manual for Environmental Laboratories* (Version 1.0, October 2000), the USACE EM 200-1-3, Appendix I *Shell for Analytical Chemistry Requirements* (February 2001), and structured to assess whether the acceptance criteria for instrument calibration and QC sample analysis (Appendix B) have been met. Table 3-1 depicts how the QC samples will be used to assess DQIs. The calculations that will be used to assess data quality are presented in Section 3.0 and the criteria that will be used to assess data quality are described in Appendix B.

Data verification techniques include accepting, rejecting, or qualifying the data on the basis of acceptance criteria defined in Appendix B. Data qualifiers that will be used for verification are listed in Table 9-3.

The data verification will be documented on the Data Verification Form (Figures 9-1A and B), which also includes the signature of the reviewer and the date of the verification. Data will not be released for use prior to completion of the data verification.

9.5 DATA VALIDATION – RECONCILIATION WITH DATA QUALITY OBJECTIVES

The objective of the data validation is to assess whether the field and chemical data are of sufficient quality to support the task-specific DQOs (i.e. end use). Field data will be qualitatively and quantitatively assessed on a project-wide, task-specific, matrix-specific, parameter-specific, and unit-specific basis. Factors that will be considered during this evaluation will include, but not be limited to the following:

- Were all samples collecting using the methodologies included in this QAPP and the task-specific FSPs?
- Were all proposed analysis performed in accordance with this QAPP and the laboratory's SOPs?
- Were the PQLs elevated and what impact if any to data usability occurred?
- Were samples obtained from all proposed sampling locations and depths?
- Do any data exhibit elevated detection limits due to matrix interference or contaminants present at high concentrations?
- Were all field and laboratory data verified in accordance with the verification protocols, including the project-specific QC objectives specified in this QAPP?
- Which data sets were found to be unusable ("R" qualified) based on the data verification results?
- Which data sets were found to be usable for limited purposes ("J" qualified) based on the data verification?
- What affect do qualified data have on the ability to implement the project decision rules?
- Can valid conclusions be drawn for all matrices for each specific task?

- Were all issues requiring corrective action fully resolved?

9.6 DATA MANAGEMENT

The individuals responsible for data management for this study include all personnel responsible for identifying, reporting, and documenting activities affecting data quality. In general, the qualifications of the individuals associated with data management activities will be commensurate with the level of expertise necessary to ensure the intended level of evaluation.

All project files will provide a traceable record for all data management activities. The laboratory will maintain a project file that includes but is not limited to the following; formulas used for data reduction, computer programs, which data transfers are electronic or manual, data review protocol, etc. All data acquired electronically will be transferred and manipulated electronically to reduce errors inherent in manual data manipulation. Data entered, transferred or calculated by hand will be spot checked for accuracy by someone who did not perform the original entries or calculations.

The laboratory will maintain a project specific file such that the analytical process can be completely reconstructed. The laboratory will preserve all information regarding sample analyses (correspondence, sample custody forms, raw data [hard copies], results, calibration records, etc.) in the project file. Data and storage and documentation will be maintained using logbooks and data sheets that will be included in the project file. Computer acquired data will also be stored on magnetic tape, disks, or other media, that can be accessed using industry-standard hardware and software for data processing, retrieval, or reporting. The laboratory will maintain all data collected for this study a minimum of nine years following submission of the data reports.

TABLE 9-1

LABORATORY DATA QUALIFIERS

Qualifier	Description
J	The analyte was positively identified, but the associated numerical value is below the practical quantitation limit and above the method detection limit; represents an estimated value
U	Analyte is not detected
B	The analyte was positively detected in a sample and in an associated blank .
E	Reported concentration is estimated; outside the linear calibration range of the instrument
D	Indicates that the concentration was calculated using a secondary dilution factor (i.e., the result is calculated from the analysis performed by diluting the sample)
G	Reporting limit elevated due to matrix interference

TABLE 9-2

DATA REPORTING REQUIREMENTS
(Page 1 of 3)

Data Type	Analysis Type	Data Reporting Requirements	Report Format
Groundwater or surface water general water quality data collected in the field using a portable meter.	—pH	—Location, date, and time sample collected —Initial and continuing calibration data —pH data	—Project-specific field form or log book —Project-specific field form or log book —Project-specific field form or log book
	—Specific conductivity (SC)	—Location, date, and time sample collected —Initial and continuing calibration data —SC data	—Project-specific field form or log book —Project-specific field form or log book —Project-specific field form or log book
	—Temperature	—Location, date, and time sample collected —Initial and continuing calibration data —Temperature data	—Project-specific field form or log book —Project-specific field form or log book —Project-specific field form or log book
	—Salinity	—Location, date, and time sample collected —Initial and continuing calibration data —Salinity	—Project-specific field form or log book —Project-specific field form or log book —Project-specific field form or log book
	—Dissolved oxygen	—Location, date, and time sample collected —Initial and continuing calibration data —Dissolved oxygen data	—Project-specific field form or log book —Project-specific field form or log book —Project-specific field form or log book

Data Type	Analysis Type	Data Reporting Requirements	Report Format
Definitive organic or inorganic data generated by a laboratory.	Level III data package for standard methods of analysis[b] or modified standard methods of analysis for organic or inorganic compounds	—Case narrative (including samples not meeting QC criteria, out of control conditions, corrective actions, and matrix effects with justification)	—Hard copy of data report
		—Completed C-O-C and sample receipt and log in forms	—Hard copy of data report
		—Initial calibration summary form	—Hard copy of data report
		—Continuing calibration summary form	—Hard copy of data report
		—Injection logs	—Hard copy of data report
		—Target compound results for all samples, including field QC samples and dilution factors, reanalysis, batching information, and bracketing information	—Hard and electronic copy of data report
		—Method blank results	—Hard and electronic copy of data report
		—MS/MSD results (spike concentration, actual values, and percent recovery)	—Hard and electronic copy of data report
		—LCS results (spike concentration, actual values, and percent recovery)	—Hard and electronic copy of data report
		—Matrix duplicate sample results (actual concentrations and RPD)	—Hard and electronic copy of data report
		—Raw data for all samples where matrix interference is invoked as the reason for MS/MSD, surrogate spike, or internal standard failure	—Hard copy of data report
		—Holding time summary	—Hard and electronic copy of data report

TABLE 9-2

DATA REPORTING REQUIREMENTS
(Page 3 of 3)

Data Type	Analysis Type	Data Reporting Requirements	Report Format
Definitive organic or inorganic data generated by a laboratory.	Level IV data package for standard methods of analysis[(b)] or modified standard methods of analysis for organic or inorganic compounds	—Case narrative (including samples not meeting QC criteria, out of control conditions, corrective actions, and matrix effects with justification)	—Hard copy of data report
		—Completed C-O-C and sample receipt and log in forms	—Hard copy of data report
		—Initial calibration summary form	—Hard copy of data report
		—Continuing calibration summary form	—Hard copy of data report
		—Injection logs	—Hard copy of data report
		—Target compound results for all samples, including field QC samples and dilution factors, reanalysis, batching information, and bracketing information	—Hard and electronic copy of data report
		—Method blank results	—Hard and electronic copy of data report
		—MS/MSD/MD results (spike concentration, actual values, and percent recovery)	—Hard and electronic copy of data report
		—LCS results (spike concentration, actual values, and percent recovery)	—Hard and electronic copy of data report
		—Surrogate results, organic analysis (spike concentration, actual values, and percent recovery)	—Hard and electronic copy of data report
		—Raw data for all samples	—Hard copy of data report
		—Sample preparation logs	—Hard copy of data report
		—Holding time summary	—Hard and electronic copy of data report

EPA 100-400 Series - Methods for the Determination of Inorganic Substances in Environmental Samples (EPA/600R-93/100, August 1999)

TABLE 9-3

DATA VERIFICATION DATA QUALIFIERS

Qualifier	Description
UB	Analyte is not detected at or above the indicated concentration due to blank contamination
B	The analyte was positively detected in a sample and in an associated blank
UK	Analyte is not detected at or above the indicated concentration based on the data validation
UJ	Possible false negative result based on QC problems identified during the data validation
J	Result is estimated based on QC problems identified during the data validation
R	Data are considered unusable based on the results of the data validation and/or field procedures evaluation

FIGURE 9-1

DATA VERIFICATION WORKSHEET
(Page 1 of 2)

Analytical Method/Analytes: ____________________ **Sample Collection Date(s):** ____________

Laboratory: ______________________________________ **MW Job Number:** ____________________

Batch Identification: ______________________________ **Matrix:** ______________________________

QC Identification[a]: ______________________________ **Page:** 1 of 2

Validation Complete: ____

(Date/Signature)

Sample No.	Sample ID	Lab. ID	Hits (Y/N)	Quals.	Comments

FIGURE 9-1

DATA VERIFICATION WORKSHEET
(Page 2 of 2)

Analytical Method: ________________________ QC Identification[(a)]: ________________________

Laboratory: ______________________________ Batch Identification: ________________________

Validation Criteria	Sample Number													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Hardcopy vs. Chain-of-Custody														
Sample Preservation Requirements														
Holding Time														
Analyte List														
Reporting Limits														
Initial Calibration														
Continuing Calibration														
Injection Time(s)														
Method Blank														
Laboratory Control Sample														
Matrix Spike/Matrix Spike Duplicate														
Matrix Duplicate														
Field Duplicate/Replicate														
Electronic Deliverable vs. Hardcopy														
Electronic Deliverable vs. Chain of Custody														

(a) List QC batch identification if different than Batch ID
A indicates validation criteria were met
A/L indicates validation criteria met based upon Laboratory's QC Summary Form
X indicates validation criteria were not met
N indicates data review were not a project specific requirement
N/A indicates criteria are not applicable for the specified analytical method
N/R indicates data not available for review

NOTES:

10.0 PERFORMANCE AND SYSTEM AUDITS

Independent technical systems and performance audits of field and laboratory activities will be conducted to assess whether sampling and analysis protocols conform to the criteria specified in the FSP and this QAPP. The systems audit is a qualitative review of the overall sampling or measurement system, while the performance audit is a quantitative assessment of a measurement system, and includes both internal and external audits. These audits will be used to assess whether the resulting data meet the task-specific DQOs, to assess whether the data comply with QC criteria, and to identify the need for corrective action. Definitive data verification and validation is also a quantitative check of the analytical process, where documentation and calculations are evaluated and verified. Data verification and validation is discussed in Section 9.0. Internal audits will be conducted by MWH, the USACE laboratory's QAO, or USACE Fort Worth District personnel.

10.1 FIELD PERFORMANCE AND SYSTEM AUDITS

Oversight of field procedures will be the direct responsibility of the MWH Field Sampling Manager, who will review all elements of the task-specific FSPs and this QAPP to ensure that the objectives of the study are met. In addition to an initial review, the sampling procedures will be reviewed as the field-work progresses so that any necessary modifications are made.

The Project Manager will conduct internal audits of field activities (sampling and measurements) to assess the performance and effectiveness of the existing quality management systems in accordance with this QAPP. The intent of these audits is to identify, correct, and prevent management problems that hinder the achievement of the task-specific DQOs.

The audits will include examining field equipment calibration and documentation records; field instrument operation records; field measurement records; field sampling records including log books and field sampling forms; sample collection, handling, storage, and transportation procedures including organization and minimization of potential contamination sources; and chain-of-custody records and procedures. Field activities will be audited at the beginning of the study to verify that all of the procedures outlined in the FSP and this QAPP are followed.

After the internal audit is completed, a debriefing session will be held for all participants to discuss the preliminary audit results. The auditor will prepare an audit evaluation report that includes observations of any deficiencies and the necessary recommendations for corrective actions. Compliance with the specifications presented in the FSP and this QAPP will be noted and noncompliance or deviations will be addressed in writing by MWH. This information will be forwarded to appropriate management with corrective actions and a time frame for implementation of the corrective actions. Deviations that impact the task specific DQOs shall be reported to the USACE Project Manager. Follow-up audits will be performed prior to completion of the study to ensure corrective actions have been implemented.

10.2 LABORATORY PERFORMANCE AND SYSTEMS AUDITS

In-house and regulatory agency audits of laboratory systems and performance will be a regular part of the laboratory's QA program. Internal audits will be conducted by the laboratory's QAO or designee, and consist of a review of the entire laboratory system and at a minimum include: examination of sample receiving, log-in, storage, and chain-of-custody documentation procedures; sample preparation and analysis; and instrumentation procedures.

An internal audit of the laboratory may be performed by MWH, at the discretion of USACE Project Manager, within six months of study start up and will include a review of the following items:

- Sample custody procedures
- Calibration procedures and documentation
- Completeness of data forms, notebooks, and other reporting requirements
- Data review and verification procedures
- Data storage, filing, and record keeping procedures
- QC procedures, tolerances, and documentation
- Operating conditions of facilities and equipment
- Documentation of training and maintenance activities
- Systems and operations overview
- Security of laboratory automated systems.

MWH will forward audit results to appropriate management and the USACE Project Manager. Deficiencies and corrective action procedures will be clearly documented in the audit report.

11.0 PREVENTIVE MAINTENANCE PROCEDURES

A preventive maintenance program is necessary for the timely and effective completion of a measurement effort for either field or laboratory programs. The preventive maintenance program for the watershed study will be designed to minimize the downtime of crucial sampling and/or analytical equipment due to unexpected component failure. In implementing this program, efforts will be focused on establishment of maintenance responsibilities, establishment of maintenance schedules for major and/or critical instrumentation and apparatus, and establishment of an adequate inventory of critical spare parts and equipment.

11.1 FIELD EQUIPMENT/INSTRUMENTS

The field equipment that will be used will be maintained and used according to the manufacturers' directions and as specified in the task-specific FSPs. It is the responsibility of the Field Team Manager to ensure that each piece of equipment is operational and is inspected on a regular basis. Any preventive maintenance or repair conducted in the field will be recorded in the field logbook or other appropriate field forms. Backup instruments and equipment will be available on-site or within short turnaround time to avoid field schedule delays.

Field instruments will be checked and calibrated before they are shipped or carried to the field, and will be checked and calibrated daily before use. Calibration check procedures are specified in the task-specific FSPs and will be performed in accordance with the manufacturer's directions.

In addition to scheduled maintenance activities, an adequate inventory of spare parts will be maintained by MWH to minimize equipment downtime. The inventory includes those parts (and supplies) that are subject to frequent failure, have limited useful lifetimes, or cannot be obtained in a timely manner should failure occur.

11.2 LABORATORY EQUIPMENT

Preventive maintenance of all laboratory equipment and instruments is essential to ensure the quality of the analytical data produced. The objective of preventive maintenance is to ensure instrument operation is appropriate for both task-specific and method DQOs. The laboratory will have a routine preventive maintenance program to minimize the occurrence of instrument failure and other system malfunctions and will have designated individuals who perform routine scheduled maintenance for each instrument system and required support activity. The following paragraphs focus on maintenance responsibilities, maintenance schedules, record keeping, and inventory of spare parts and equipment.

Maintenance Responsibilities. Maintenance responsibilities for laboratory equipment will be assigned to designated personnel. These individuals will establish maintenance procedures and schedules for each major equipment item. The instrument manufacturer service engineers will perform instrument maintenance and repair, as scheduled/needed. The analysts will perform other routine preventive maintenance tasks. Only qualified individuals will perform any maintenance activities.

Maintenance Schedules. Maintenance schedules are based on the manufacturers' recommendations and/or sample load. Maintenance activities for each instrument will be documented in a maintenance logbook, as described below.

Record Keeping. All instrument maintenance will be documented in instrument-specific bound logbooks, which are kept with the instrument. The date, initials of the individual performing the maintenance and the type of maintenance will be recorded in this logbook. Receipts from routine maintenance performed by the manufacturer's representative will be filed in the appropriate laboratory department (e.g., ion chromatograph maintenance receipts are stored in the organic section). This logbook will serve as a permanent record that documents any routine preventive maintenance performed, as well as any service performed by external individuals such as manufacturers' service representatives. In addition, all receipts from routine maintenance performed by manufacturers' representatives will be maintained in the laboratory's file. These records will be made available upon request during external audits.

An adequate inventory of spare parts will be maintained to minimize equipment down time. This inventory will include those parts (and supplies) which are subject to frequent failure, have limited useful lifetimes, or cannot be obtained in a timely manner.

Contingency Plan. In the event of instrument failure, every effort will be made to analyze samples by an equivalent alternate means within holding times. If the redundancy in equivalent instrumentation is insufficient to handle the affected samples, MWH will be immediately notified and the corrective action to be taken will be determined by the MWH Field Sampling Manager, the USACE laboratory, and the USACE Project Manager.

12.0 CORRECTIVE ACTIONS

12.1 CORRECTIVE ACTION REQUIREMENTS

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out of quality control performance that may affect data quality. All proposed and implemented corrective action will be documented in the regular quality assurance reports to the appropriate project management as defined in Section 2.0 of this QAPP. Corrective action will be implemented only after approval by the Project Manager or designee, and the Field Team Manager. If immediate corrective action is required, approvals secured by telephone from the Project Manager will be documented in an additional memorandum

For each incidence of noncompliance, a formal corrective action program will be established and implemented at the time the problem is identified. The individual who identifies the problem will be responsible for notifying the MWH Field Sampling Manager, who in turn will notify other project managers. Implementation of corrective action will be confirmed in writing as described previously.

Any nonconformance with the established QC procedures specified in the FSP or this QAPP will be identified and corrected in accordance with the QAPP. Corrective actions will be implemented and documented in the field logbook. No staff member will initiate corrective action without prior communication of findings through the proper channels.

12.1.1 Field Corrective Action

During any field activity, the field staff will be responsible for documenting and reporting all suspected technical and QA nonconformances, and suspected deficiencies. The nonconformances and/or deficiencies will be documented in the field logbook and reported to the MWH Field Sampling Manager. If the problem is associated with field measurements or sampling equipment, the field staff will take the appropriate steps to correct the problem. Typical field procedures to correct problems include the following:

- Repeating the measurement to check for error
- Making sure the meters or instruments are adjusted properly for ambient conditions, such as temperature
- Checking or replacing batteries
- Recharging batteries
- Recalibrating the instruments
- Replacing the meters or instruments used to measure field parameters

- Stopping work (if necessary) until the problem is corrected.

If a nonconformance or problem requires a major adjustment to the field procedures outlined in the FSP or this QAPP (e.g., changing sampling methodology or sampling schedule), the MWH Field Sampling Manager, in conjunction with other project managers, will be responsible for initiating corrective actions and notifying USACE Project Manager. The MWH Field Sampling Manager will be responsible for:

- Evaluating the reported nonconformance.
- Controlling additional work on nonconforming items.
- Determining the appropriate corrective actions in conjunction with appropriate project managers and USACE Project Manager.
- Maintaining a log of all nonconformances and corrective actions.
- Approving all changes in writing or verbally prior to field implementation, if feasible. If deemed unacceptable, the action taken during the period of deviation will be evaluated to determine the significance of any departure from established program practices.
- Ensuring that explanation of nonconformances and corrective actions is included in an appendix to the report scheduled for this investigation.
- Ensuring that no additional work that is dependent on the nonconforming activity is performed until the appropriate corrective actions are completed.
- Reporting all changes to all affected parties, including the USACE Project Manager.

12.1.2 Laboratory Corrective Action

Corrective actions are required whenever unreliable analytical results prevent the quality control criteria from being met, as specified by the analytical method; the laboratory's SOPs, or this QAPP. The corrective action taken depends on the analysis and the nonconformance. A summary of corrective actions that will be undertaken for problems associated with specific laboratory analyses is provided in Appendix B of this QAPP.

Corrective action will be undertaken if one of the following occurs:

- Blanks consistently contain target analytes above acceptance levels.
- Undesirable trends are detected in spike recoveries, spike recoveries are outside the QC limits, or RPDs between duplicate analyses are consistently outside QC limits.

- There are unusual changes in detection limits.
- Deficiencies are detected during QA audits.
- Inquiries concerning data quality are received from MWH's Project Chemist.

The analyst who reviews the sample preparation or extraction procedures, and performs the instrument calibration and analysis will handle corrective actions at the bench level (primarily). If the problem persists or its cause cannot be identified, the matter will be referred to the department supervisor or QA department for further investigation. Once resolved, full documentation of the corrective action procedure will be filed with the appropriate laboratory QA department. A summary of the corrective actions will be included in the data reports.

12.1.3 Data Verification Corrective Actions

Corrective action may be initiated during data verification or data assessment. Potential types of corrective action include resampling by the field team or reanalysis of samples by the laboratory.

Corrective actions that will be taken are dependent upon the ability to mobilize the field team, how critical the data are to the task-specific DQOs, and whether the samples are still within holding time criteria. When a corrective action situation is identified by the Project Chemist, the MWH Field Sampling Manager and the other project management will be notified, and will have responsibility for authorizing the implementation of the corrective action, including resampling and documenting the corrective action and notifying the USACE Project Manager for authorization.

13.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Deliverables associated with this study will contain separate QA sections in which data quality information collected during specific tasks is summarized. Deliverables include the Daily Quality Control Reports (DQCRs) and reports that summarize the findings. Submission of these reports is the responsibility of the Project Manager. Quality assurance sections will identify all QA samples collected and the corresponding primary samples and will report accuracy, precision, and completeness of the data as well as the results of the performance and system audits, and any corrective action needed or taken during the project. The DQCRs will be included in the documents submitted to the USACE Project Manager.

14.0 REFERENCES

Department of Defense, October 2000. *Quality Systems Manual for Environmental Laboratories.* Version 1.0

MWH Americas, Inc., 2002a. *Sampling and Analysis Plan – Bosque and Leon River Watersheds Study*; comprises the sampling and analysis plan (SAP), quality assurance project plan (QAPP), site safety and health plan (SSHP), and the task-specific field sampling plans (FSPs). Prepared for the U.S. Army Corps of Engineers, Fort Worth District. July 2002.

U.S. Army Corps of Engineers, 2001. *Requirements for the Preparation of Sampling and Analysis Plans*. EM 200-1-3.

U.S. Environmental Protection Agency, 1994a. *Guidance for the Data Quality Objectives Process, EPA* QA/G-4. EPA/600/R-96/055.

U.S. Environmental Protection Agency (EPA), 1999. USEPA Contact Laboratory Program National Functional Guidelines for Organic and Inorganic Data Review, Office of Emergency and Remedial Response, Washington D.C., 1994.

U.S. Environmental Protection Agency, 1999. *Method 314.0 - Determination of Perchlorate in Drinking Water Using Ion Chromatography*. Revision 1.0, November 1999.

U.S. Environmental Protection Agency, 2000. *Data Quality Objectives for Hazardous Waste Site Investigations*, EPA QA/G-4HW. EPA/600/R-00/007.